An Epistemic Model for Moral Hazards in Scientific Enterprises

Jean Maria Arrigo, Irvine, CA, USA

Maj-Britt Juhl Poulsen, Department of Medical Philosophy and Clinical Theory, University of Copenhagen, Denmark

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The immediate connection between successful science and ethical science is weak, so any urgency for successes may invite ethical lapses. We present a model of the dynamics between methods and morals in scientific enterprises. The developmental course of scientific enterprises generates characteristic moral hazards and opportunities, as we exhibit in our case study of a collaboration between two biomedical research teams. Lastly, we argue that our model offers conceptual gains in unifying "ethics of research" and "ethics of application" (1, p. 503) and offers practical gains in guiding codes of science ethics.

Interviews with biomedical researchers (2) and with military intelligence professionals, together with archived oral histories of weapons researchers, underlie our model (3). Reviews by military intelligence interviewees improved it iteratively.

A Model of Methods and Moral Hazards in Scientific Enterprises

In our model, the 17th Century Enlightenment vision of science constitutes the prototype of a *cooperative epistemology* (theory of knowledge). Epistemic partners freely share targets of inquiry, observations, and analyses. Empirical inquiry generates layers of knowledge through: (a) observation of a phenomenon, (b) analysis of observations, (c) meta-analysis of analyses, and so on.

Political and military intelligence, in contrast, constitutes the prototype of an *adversarial epistemology*. Epistemic adversaries may conceal targets of inquiry, observations, and analyses, and may spy on or sabotage the Adversary's inquiries. Empirical inquiry by agent and adversary generate interleaved layers of knowledge through: (a_1) Agent's investigation of a phenomenon (e. g., Manhattan Project study of nuclear fission), (a_2) Adversary's possible investigation of the phenomenon (e. g., possible Japanese study of nuclear fission in World War II), (b_1) Agent's investigation of Adversary's possible investigation through espionage, (b_2) Adversary's investigation of Agent's possible espionage, and so on. Each investigation by Agent or Adversary includes all the processes of observation and analysis in cooperative investigation above—and is often performed by an epistemic subcontractor, such as a scientist or historian, with cooperative methods. The

Corresponding author: Maj-Britt Juhl Poulsen, Department of Medical Philosophy and Clinical Theory, Build. 22.3, University of Copenhagen, Panum Institute, Blegdamsvej 3, DK-2200 Copenhagen N, Denmark, +45 3532 7596 (voice), +45 3532 7938 (fax), m.poulsen@pubhealth.ku.dk; for reprints: Jean Maria Arrigo,110 Oxford St., Irvine, CA 92612, jmarrigo@pacbell.net .

Adversarial Epistemology		Cooperative Epistemology	
I.	Partisanship: the goal of inquiry is conscious, strategic advantage over an Adversary.	I'.	Impartiality: the goal of inquiry is knowledge *per se* or its nonpartisan utility.
II.	Deceptiveness of phenomena: all observations are vulnerable to deliberate deception by the Adversary, whether by omission or commission.	II'.	Accessibility of phenomena; the natural world is not inherently deceptive (René Descartes' premise).
III.	Urgency: the Adversary is dangerous and implacable so decision is urgent in the short run.	III'.	Deliberation: method leaks to superior results in the long run (Charles Peirce's "self-corrective" hypothesis).
IV.	Suborindation: researchers' clients govern the broad topics, opportunities, and constraints of inquiry.	IV'.	Independence: researchers themselves govern the topics and methods of inquiry.

Table 1. Poles of the epistemic continuum

adversarial epistemology is thus far more complex than the *cooperative epistemology*. The complexity encourages intuitive or artful approaches in attributing intentions and meanings to the adversary's behavior. Our formulation contrasts the rational basis of military and political intelligence with the rational basis of science.

A recent headline story of scientific misconduct illustrates the interleaving layers of adversarial investigation. In 1981 the archeologist Shinichi Fujimura (Agent) unearthed the oldest artifacts in Japan, 40,000 years old. Some critics (Adversary) became skeptical of his celebrated discoveries, which by 1993 had pushed the origins of Japanese civilization back 700,000 years. Mindful of their suspicions, Fujimura surreptitiously buried artifacts that he later "discovered" in the presence of witnesses. Journalists documented with hidden video cameras his burials of artifacts. Anticipating Fujimura's defenders, the journalists filmed Fujimura's fraud at a second site before exposing him. Aware of the limitations of the journalists' investigations, Fujimura denied planting artifacts at sites he had excavated previously. Japan's Cultural Affairs Agency, now doubting Fujimura, plans reviews of his earlier excavations. Critics speculate that Fujimura's subterfuge may have set back Japanese archeology a decade (4).

The Epistemic Continuum

The adversarial and cooperative prototypes stand as opposite poles on a continuum of epistemic commitments. Cosmology and plant taxonomy lie towards the cooperative pole. Biological warfare research and forensic psychiatry lie towards the adversarial pole. Biometrics, clinical trials, educational testing, and research in the social constructionist paradigm occupy intermediate positions.

Four principles separate the most extreme positions of the *adversarial epistemology* from the corresponding principles of the most extreme positions of the *cooperative epistemology*, as stated in Table 1 (5).

In the *adversarial epistemology*, deception by the adversary leads to secrecy, compartmentalization of knowledge, reward of researchers on the basis of loyalty as well as ability, and organizational structures that limit the scope of inquiry. Repeated use of any research technique or conceptual schema offers the adversary an opportunity for sabotage, which raises the value of innovation over perfection. Urgency creates trade-offs between accuracy and utility. Fear of surprises from the adversary promotes crude study of broad fields in preference to fine study of narrow fields. Researchers' subordination to decision makers creates a distinction between the complex pattern "knowledge" held by researchers and the simplistic linear "information" provided to clients for decision making.

Consideration of typical epistemic adversaries in science-related enterprises suggests the pervasiveness of adversarial epistemic methods, as indicated in Table 2.

A Case Study of Competition and Cooperation among Biomedical Teams

Biomedical research can be described as collective research, for cooperation among individuals is necessary to reach the goals of research. At the same time, biomedical researchers need credit for their work and discoveries to make a career and to bring their own research programs to fruition. In this way the interplay of cooperation and competition is an

Domains of Inquiry	Common Epistemic Adversaries of Researchers	Historical Prototypes
Basic sciences	Colleagues, rivals, proponents of conflicting paradigms, ethics committees, institutional authorities, peer reviewers, funding agencies	Watson & Crick, *The Double Helix*
Medical sciences	Institutional Review Boards, regulatory agencies, Health Maintenance Plans, alternative healthcare practitioners, patients, animal rights advocates, hospital administrations, malpractice attorneys, news media	Tuskegee syphilis study
Social sciences	Cultural or identity groups, privileged economic and social classes, legislators, courts, admissions and ethics committees, hate groups	*Brown v. Board of Education* (school desegregation)
Industrial research	Industrial competitors, whistleblowers, labor unions, customers, consumer advocates, regulatory agencies, environmentalists	Tobacco industry cancer research
Weapons research	Enemy states, allied states, spies, terrorists, news media, social activists	Manhattan Project

Table 2. Common epistemic adversaries

essential element of daily practice. These internal dynamics may swing a project between the cooperative and adversarial modes. Therefore, during the course of scientific enterprises researchers may face new or unexpected moral challenges.

Identifiable conditions make a biomedical project swing either in the competitive direction or the cooperative direction. Adversarial conditions, for example, include colleagues' overlapping goals and/or methods; proximity to project completion and therefore to allocation of credits; limited resources; and, at a personal level, researchers' hidden agendas and breach of confidence. Cooperative conditions include (also) colleagues' overlapping goals and/or methods of project; complementary skills or resources; the need for face-to-face meetings; and, at a personal level, friendship and trust.

Our case study of competition and cooperation among three biomedical research teams illustrates the natural fluctuation between the adversarial and cooperative poles. A virology research team sent a young researcher to study abroad for a year with a cellular biology team, because of its expertise with a certain protein. His hosts encouraged the visiting virologist to present his research results at a conference. They also urged him to publish the "hot" results quickly, but he delayed. The biology team subsequently confirmed the results experimentally and proposed to take a subordinate role in a joint publication with the virologists. However, the virologists wished to publish alone first. Meanwhile, a second cellular biology group contacted the first and implied that they (also) had experimentally confirmed the results announced by the visiting virologist at the conference, and this second group of biologists intended to publish independently right away. The first biology group communicated this turn of events to the virology group, which began writing immediately.

In this narrow case we identify conditions that support cooperative practices, such as complementary skills, and conditions that support adversarial practices, such as allocation of credit at publication. The cooperation between the first cellular biology team and the virology team was established due to complementary expertise. The swing towards the cooperative pole was enhanced by a longer stay of one virologist with the cellular biology team. The desire to obtain credit made the project swing towards the adversarial pole and was enlarged by a hidden agenda on the part of the virology team, who wished to publish alone first. Competition from another cellular biology team made the project swing back towards the cooperative pole. Indeed, the methods and norms of science drive research projects along a typical trajectory of moral hazards and opportunities.

As this and other studies show (e.g., 6) biomedical projects can be seen as intermediary between the adversarial and cooperative poles. In particular situations, it can be very difficult to distinguish adversarial from cooperative epistemic orientations. The model provides a point of reference by stating that the key difference between adversarial and cooperative epistemologies is deliberate deception.

Utility of the Model

The epistemic model offers both conceptual and practical gains to science ethics. Conceptually, the model serves as a unifying schema for issues in science ethics. Two classes of scientific misconduct are commonly distinguished. The "ethics of research" is largely concerned with the means of competition among researchers, such as strategic secrecy. The "ethics of application" is concerned with the means used to attain scientific and technological ends, such as creation of toxic wastes (1, p. 503). These two classes are distinguished by the types of harm produced. The epistemic continuum accommodates the ethics of research and the ethics of application in a single schema. The harms change, but the adversarial epistemic principles that lead to the harms remain the same! Deception of colleagues in recording data and deception of research subjects in promising medical cures both follow the same adversarial epistemic principle of deception of the adversary, although the corruption of science and the injury to persons are ontologically different harms. The epistemic model identifies misconduct in science according to the principles of adversarial inquiry employed in the misconduct rather than the nature of the harm.

Further, the model guides study of the interaction between cooperative and adversarial epistemic methods. Cooperative epistemic methods lead to specialization, perfection of methods, and accountability in applications. Adversarial epistemic methods lead to expansion of domains, innovation in methods, and speed of application. To what extent are adversarial methods actually separable from cooperative methods in scientific projects? What are the costs and benefits of eliminating adversarial methods? How can beneficial and destructive competition be characterized?

As a practical contribution to science ethics codes, the model translates ethical problems in science—which philosophy of science cannot directly address—into products of a competing epistemology—which philosophy of science is better equipped to address. For typical research projects, epistemic adversaries and collaborators can be specified across the stages of the project, and typical moral risks and opportunities can be assessed.

The model highlights what we call *the tracking problem*: the original moral rationale for a project may cease to apply as the project evolves. For an example from ethics of application, the Manhattan Project authorized a metabolic plutonium experiment on unwitting, terminal patients, to gauge effects of plutonium exposure on bomb production workers. In 1944 many people would have agreed that the national security interest morally superseded the rights of patients, who were expected to die before the plutonium affected them adversely. But some of the patients survived for decades and suffered severe damages from plutonium injections, which invalidated the original moral rationale. For an example of the tracking problem from ethics of research, in our case study of three biomedical research teams, the rationale for the project appeared to change during the course of the project. At first the advancement of knowledge was the ultimate objective, which includes the obligation to publish results as soon as possible. This objective was superseded in later stages by the objective to obtain credit for discovery. A key ethical requirement for a scientific project would be to show how the original moral rationales, if needed, track along with the anticipated course of the project.

The fluctuation between cooperative and adversarial modes addresses the limitations of front-end solutions to moral problems in science, such as voluntary informed consent of subjects and authorship agreements. As a further contribution to science ethics codes, the epistemic model invites consideration of the most effective points of intervention for ethical codes. The model also suggests addressing potentially adversarial roles with support for the weaker party instead of only admonitions to the stronger. For example, to moderate the potentially adversarial roles of researcher and graduate student assistant, ethical codes might standardize support for the student in the form of a mentor at another institution.

Philosopher Henry Sidgwick, who laid the foundations for 20th Century ethics, considered whether society would be more improved by correction of character flaws, so as to gain the capacity to follow our moral convictions, or by moral understanding, so as to gain insight into the consequences of our actions. Sidgwick (7) advocated education of moral understanding on the grounds that strong character coupled with conviction leads to the most serious moral offenses. Historically, this has been the danger for science. The epistemic model for scientific misconduct follows Sidgwick in offering moral understanding for science ethics education.

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